Socapel PAM
A Programmable Axes Manager

CamMaker V1.0

User's Manual

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This upgraded and improved version replaces all the previous. We reserve the right to amend this document without prior notice and decline all responsibilities for eventual errors.

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1. WHAT IS CAMMAKER ?

CamMaker is a graphical design help for cam pipe blocks.
From a given set of points and some constraints, it calculates a complete cam shape.
To do that, it use the same interpolation algorithm as PAM. So the user gets from the PAM cam pipe block what CamMaker has displayed.
It is possible to visualise the position, speed, acceleration and jerk diagrams
CamMaker store the cams in a special format (.IFC) which contains the given set of points, the constraints and other internal information. It also provides a file (.PCC) directly usable by the PAM compilator (since PAM SYSTEM V2.5_1.)

1.1 HOW TO USE THIS MANUAL ?

The first part (Getting started) gives you the minimum information to use CamMaker.
The second (What does CamMaker improve ?) tells you more about the CamMaker philosophy.
The third (Interpolation rules) explains how the interpolation is done and can help you to understand profile's "behaviour".
The fourth gives you additional possibilities and descriptions of CamMaker.

2. GETTING STARTED

2.1 INSTALLATION

To install CamMaker:

- Insert the first disk of CamMaker in the disk drive.
- In the Program manager of Windows (main window), select the Execute option of the File menu.
- Type: `a:setup` where `a` is the name of your disk drive.
- Click on OK.
- Follow the instructions.

By default and if any other SOCAPEL tools are already installed, the < target directory> is: C:\SOCATOOL .
The modifications done in the configuration files are:

```
WIN.INI:
      [Socapel Tools]
      BaseDirectory=<target directory>

SOCATOOL.INI (located in the target directory):
      [Help]
      Directory=<help directory>

AUTOEXEC.BAT information:
      ...
      SET PATH= ........ ;<target directory>
```

2.2 HOW TO CREATE A CAM ?

CamMaker must have some "user's point" to build a cam. Those are the points the user define, through which the cam have to go.
You can then create a new cam defining these points in a CSV file but you can also reuse cams you have created with PAMCAM utility. In this case, the points are extracted from the PCF file.

2.2.1 CREATE A NEW CAM WITH CSV FILE

To build a new cam, you have then to define user's points in a CSV file. You can create such a file with a spreadsheet (e.g. Excel) following some rules:

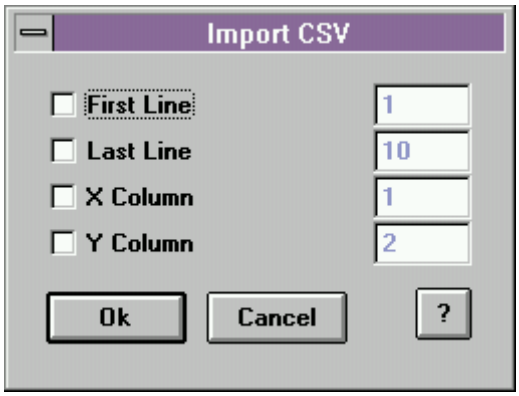
- The points don't have to be evenly distributed on the X axis.
- Minimum number of points: 4
- Maximum number of points: 800
- All values for x and y can be **floating point** number or **integer** (transformed to floating point in CamMaker).
- The decimal separator must be a point.
- Save as a CSV file (comma or semicolon as separator).

You can also directly create such a file with a text editor.

Example

```
0,0
2,1.1
4,3
8,4.2
9.8,2.9
16,0
```

When the points are defined, run CamMaker and open the CSV file either selecting New in the File menu or clicking on in the toolbar. Choose the CSV file and click OK
The "Import CSV" dialogue box is then open.



You can define here which data's of the CSV file have to be extract as user's points.
By default, the program will search x data in one column from the first line to the last one, then it passes to the next column until it finds the first data valid (one reel or integer number). The search begins at the column 1, line 1 until the last line in the last column -1.
But if you have build a special file (other insignificant values before user's point definition) you can select in which columns and lines the usable points are.

2.2.2 REUSE PCF FILES

CamMaker can import previous PAMCAM files with PCF extension (as long as they have less than 800 points).
When you want to convert an old PCF file:

Run CamMaker and open the file either selecting New in the File menu or clicking on in the toolbar.
Don't forget to select PCF file format in the Open dialogue box.

Warning! Check your cam at screen, because, as PAM 2.5, CamMaker uses the cubic interpolation; some differences with previously used parabola interpolation are then possible.

To limit the size of the CAM file (thus, save precious PAM memory…), you should convert your existing cam not from PCF file but (if they still exist) from the CSV. In that case, you can remove superfluous points (e.g. points which are in a straight segment).

2.3 HOW TO MODIFY A CAM ?

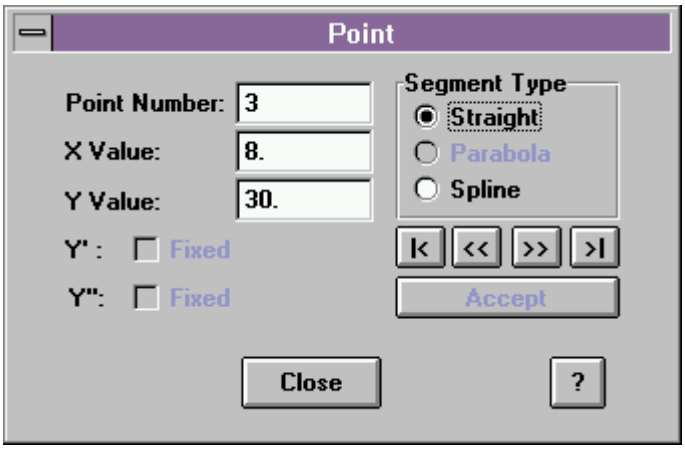
CamMaker is made to give you the possibility to tune the cam you have defined with your points in the CSV or PCF file. You can act on the cam shape by different ways.

2.3.1 CYCLIC PARAMETER

This parameter allows to define a cam which will be executed cyclically. It means that, when the axis which is attached to the cam will run continuously, when the end of the cam is reached, the same cam is executed again.
By default, this parameter is **on**.
To remove it, select the Cyclic option in the Cam menu.

2.3.2 USER'S POINTS VALUES

In the "Point" dialogue box, you can modify the value (either in X or Y) of each point you have defined.



You can open this dialogue box by three ways:

- Select the Point option of the Cam menu.
- Click on in the toolbar.
- Double click at right of the wanted point.

You have to validate each modification with

Modified Y value must stay between y values of the previous and the next points.
You can not add or remove points.

2.3.3 CONSTRAINTS

At each point, you can define some constraints. It means you can define the interpolation method for the next segment. There are three kinds of interpolation:

- straight: the point is linked to the next with a straight line.
- parabola: the point is linked to the one after the next with a segment of parabola. It means that the next point is also on this segment of parabola and that it has also automatically the parabola constraint.
- spline: the point is linked to the next with a spline (third degree equation).

Depending on the constraints of the previous and next points, some constraints can be unavailable.

You have to validate each modification with

2.3.4 FIXED VALUES

At any point, you can fix the value of the derivative (speed) second derivative (acceleration).

As for the constraints, depending on the constraints already defined, you can not always fix these values.

You have to validate each modification with

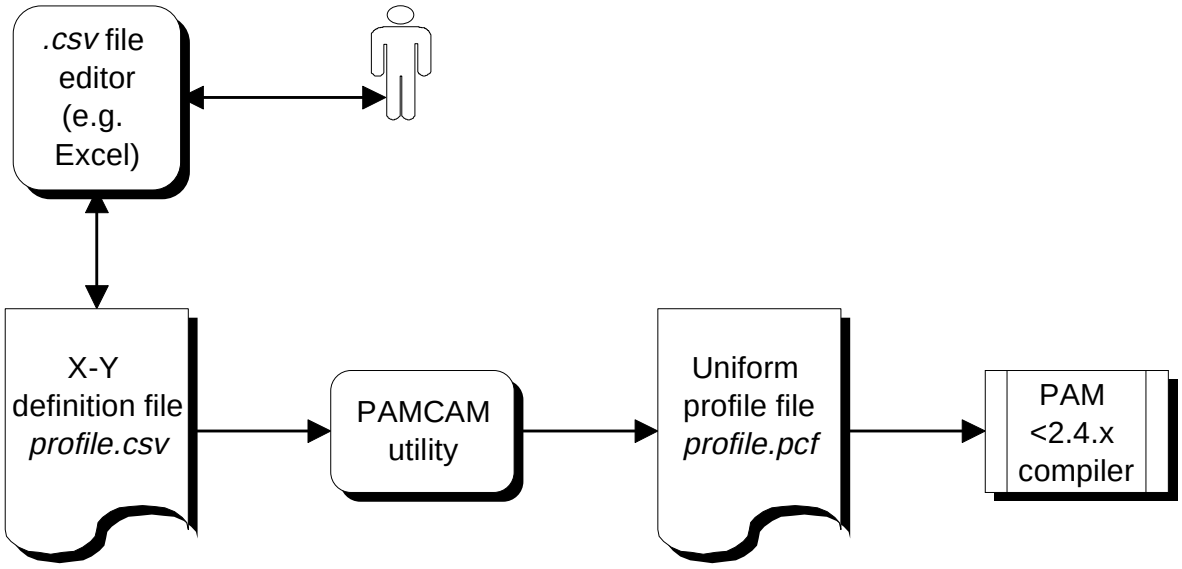
3. WHAT DOES CAMMAKER IMPROVE IN CAM DESIGN?

Before CamMaker, the cam shape was impossible to control, because the interpolant calculation was done by PAM at initialisation time, with a parabolic spline method; worse, the values between points were not accessible to the user, or only roughly measurable with the DAC output, leading the user to specify a large (100 or more) number of definition points for a profile.

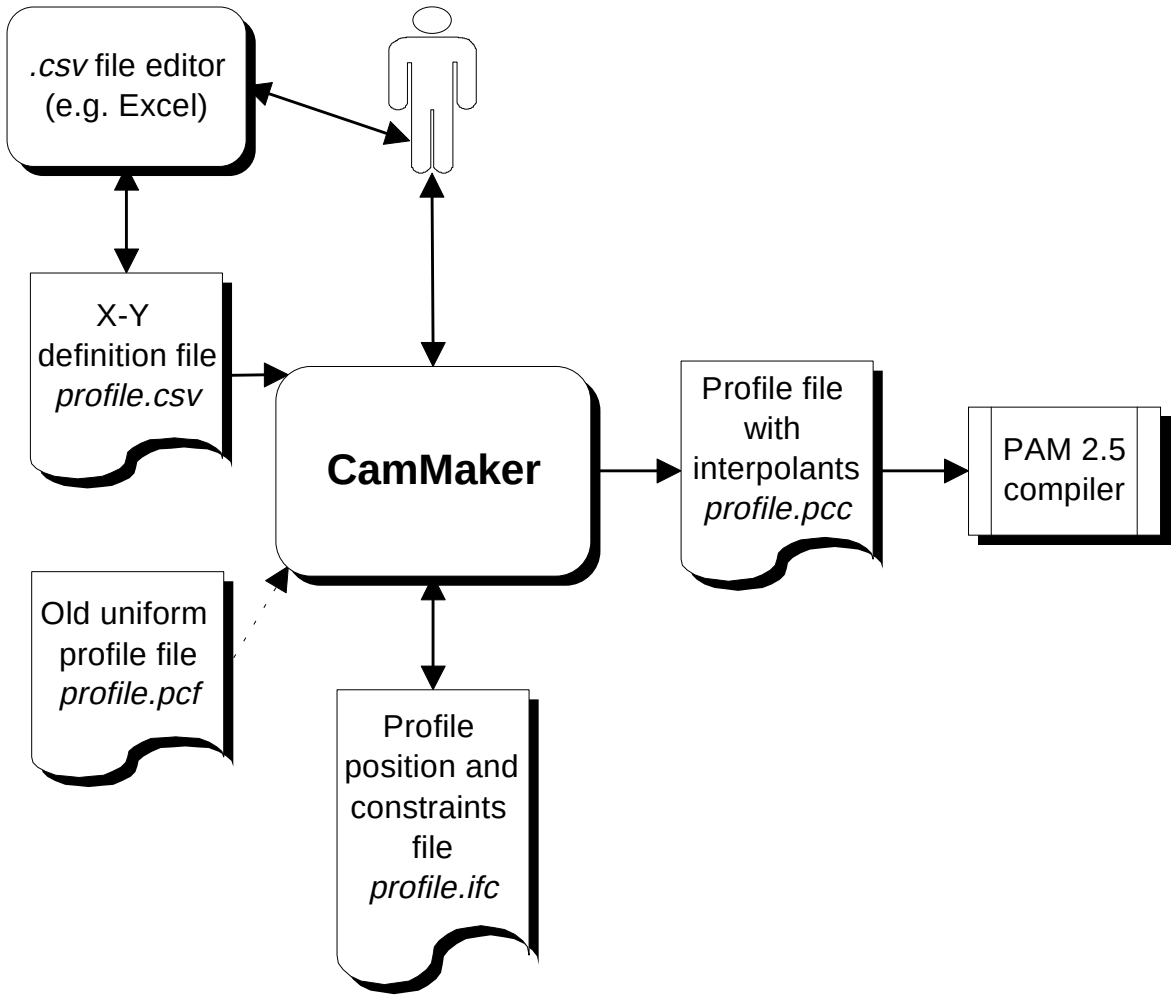
Another significant change is a new file format (the .IFC format), specific to CamMaker, to keep all information needed to obtain the result given to PAM. This file contains the position table copied from the position points file (e.g. .CSV file), all the constraints given by the user, and other information.

The file use changes can be summarised as follows:

Before CamMaker with PAM 2.5 :



With CamMaker and PAM 2.5 :



Please notice the impossibility (inherent to mathematics behind CamMaker) to get the constraints information from the interpolants, or, in other words, to revert from a .PCC file to its .IFC source file.
An important feature of CamMaker is its ability to handle nonuniform segmentation: before, with PAMCAM, all the points defining a cam had to be separated by the same interval along the variable axis (abscissa); now it is possible to adjust the definition points density to the local complexity of the cam profile, thus saving PAM non-volatile memory for the application itself, or allowing much more profiles to be stored. For this reason, the .PCF format, containing only ordinate data with implicitly uniform abscissa, cannot be accepted by PAM compilers for versions 2.5 and above; it is easy to obtain the same profiles as defined under previous versions, with the corresponding .CSV files as an input to CamMaker, but it may be wise to eliminate all superfluous points.
Another significant improvement brought by CamMaker is an efficient control upon the transfer characteristics of the cam pipe block, because CamMaker uses the same source code as PAM for the position profile calculation.

4. INTERPOLATION'S RULES

A) All segments between points are interpolated by PAM with a cubic polynomial. For any set of more than 2 consecutive spline segments, i.e. without any straight line or parabola specification, the equations derived from speed and acceleration continuities are incomplete, requiring the specification of two additional constraints to define the coefficients of all interpolation segments. These constraints can be given in various ways:

- If nothing is specified at all for the complete cam, CamMaker will add a third derivative (jerk) continuity condition at second and at penultimate points, called "not-a-knot" condition in the computer graphics literature.
- For a cam without any straight line or parabola, you can freely choose two conditions, either at the same point (explicitly fixing speed and acceleration at it), or at two different points, each with the choice to fix speed or acceleration. If you choose only one condition, the "not-a-knot" default condition will be used at the most distant extremity from the point chosen.
- By ordinary boundary conditions: if, for instance, the cam has at least one straight line or parabola somewhere in its "middle", the spline curve starting from first point and the one ending at the last point will have one of their extremities connected to a segment with fixed speed and acceleration: for each of these spline curves, only one condition is still to be specified. By default, the "not-a-knot" extremity condition will be used by CamMaker.
- By implicit boundary conditions: if the cam is declared as cyclic, both speed and acceleration at end point will be the same as at first point, giving the two additional conditions. This is the default choice at start-up.

B) For mechanical reason (no motor can follow a speed jump, i.e. an infinite acceleration), CamMaker will force the whole cam to be continuous for speed (and of course, position). Moreover, within all spline curve sections, acceleration continuity is also ensured. It means that some rules must be follow when you set constraints.

- In the position diagram, you cannot specify a straight line from A to B and another one from B to C: either point B is on the straight line A-C and is therefore superfluous, or segments A-B and B-C will form a non-flat angle, giving at point B some speed discontinuity.
- If one has specified a straight line between points B and C, CamMaker will prevent any straight line specification for adjacent segments A-B and C-D, and one cannot fix speed or acceleration at points B or C because the straight line specification already defines them.
- For the same basic reason, if a parabola joining points A, B and C (i.e. a constant acceleration) has been specified, neither a straight line between C and D nor a parabola between C, D and E can be accepted.

C) Two fixed segments, straight or parabola, can be « joined » by insertion of a small unspecified segment to ensure speed continuity, but, if this joint is too small, an acceleration jump may appear too large.

D) A little caveat: cubic spline set is a non-local object! If, for a given set of consecutive segments without straight line or parabola specification (i.e. a spline curve), you change a condition at any point, this will affect all the segments of the spline curve: especially on large sets of points (> 50 or so), this can give rise to surprisingly large values between points, simply because it's the solution of the equation system. The only way to break this non-locality is to insert a straight line or a parabola to "separate" the spline curve into two parts: such a segment can be very tiny, but if it exists, its neighbouring spline curve sections won't interact anymore.

5. OTHER DESCRIPTIONS AND POSSIBILITIES

5.1 BUILDING UTILITIES

5.1.1 MARKERS

You can set two markers to get some information about the profiles at particular point X.

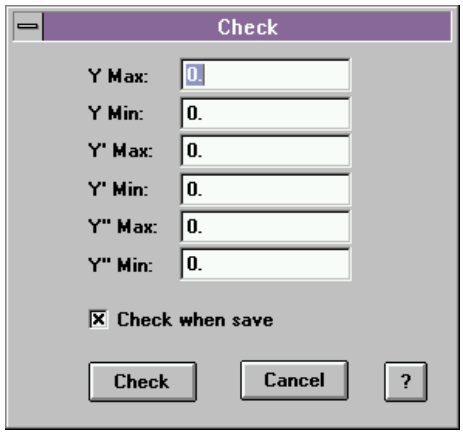
- Set marker 1:
  Shift + Left mouse button.
  Shift + Ctrl + Left mouse button: marker on nearest "user's point".
- Set marker 2:
  Shift + Right mouse button.
  Shift + Ctrl + Right mouse button: marker on nearest "user's point".

You can then see in the window:

- Marker's name (M1 or M2) is shown above the marker's dotted line
- Markers position is shown on top of the cam window (M1 at left, M2 in the middle). If a marker is outside the profile graphic area, its position is not shown. A star (*) indicates if the marker is on a user's point.
- Delta between markers 1 and 2 is shown also on top of the cam window (at right).
- Each profile's value at markers position is shown near the intersection of the profile and the marker's dotted line.
- For each profile, the difference between the value at marker 1 and the one at marker 2 is shown at the upper right corner of the profile graphic area.

5.1.2 CAM CHECK

In some cases, interpolation can produce under- and overshoot. It means that the highest cam profile value can be bigger than the higher user's point and the lowest cam profile value can be lower than the lowest user's point. So the Cam Check function can help you to check if the cam profiles (as well position as speed, acceleration or jerk) don't exceed certain limits.
To check your cam, select the Check option in the Cam menu.



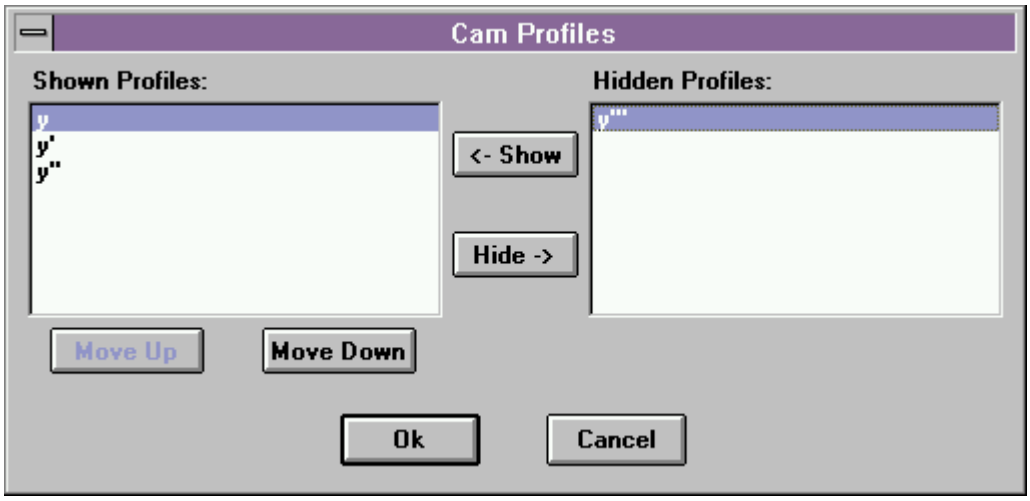
By default, the Cam Check dialogue box is also automatically opened when the cam is going to be saved.

5.2 CAMMAKER'S WINDOW DESCRIPTION

5.2.1 SHOWN PROFILES

The cam profile dialogue box gives you the possibility to select the profiles shown.

Open this dialogue box with either the Profile selection of the Cam menu or clicking on in the toolbox.



You can change the order in which the profiles appear selecting the profile you want to move and using the Move Up and Move Down buttons.

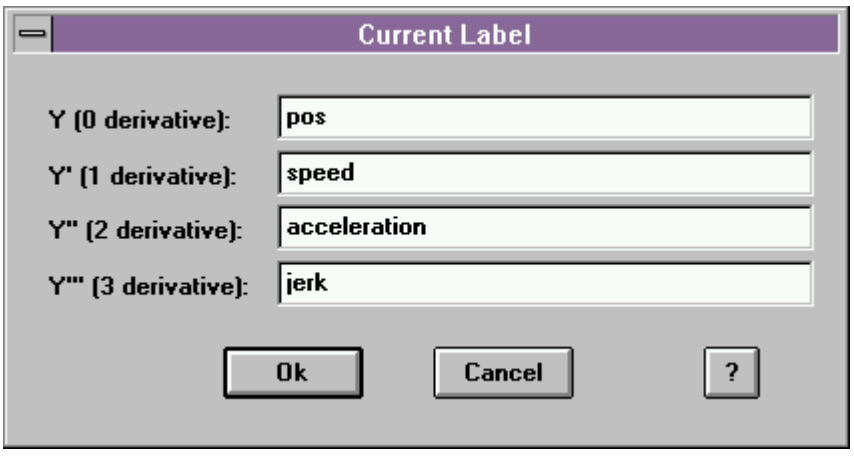
5.2.2 LABELS

The labels are shown on top of each profile. By default, they are:

y	cam position
y'	first derivative (speed)
y''	second derivative (acceleration)
y'''	third derivative (jerk)

With the cam labels dialogue box you can define your own label for each profile.

Example of personal labels:



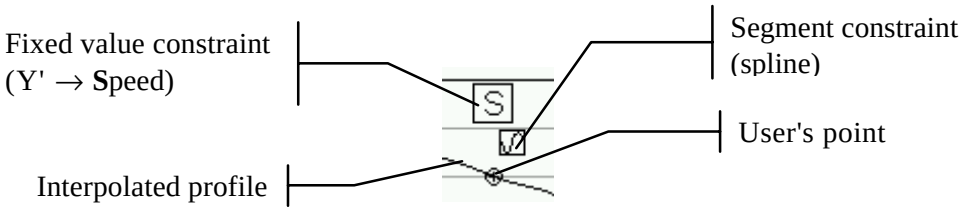
You can also define the default labels which are get when a new cam is created. To do it, select the Default labels option in the Option menu.

5.2.3 GRID

By default a grid is drawn in the background of each profile. You can hide it with the Grid option of the View menu or directly clicking on in the toolbox.

5.2.4 POINT

By default, the user's points are shown (except if the scale is in such a way that they are too close to each others).
The points are shown as circles with above the segment constraint and, if any, the fixed value constraint.



You can hide them either with the User points option of the View menu or directly clicking on in the toolbox.

5.2.5 ZOOM

You can modify the view area.
Horizontal zoom:

- Click the left button in a profile graphic area (which is defined for each profile as the shortest rectangle including the whole shown part of the profile).
- Hold the button down.
- Drag the mouse to define the zoom size.

Area zoom:

- Click the right button in a profile graphic area.
- Hold the button down.
- Drag the mouse to define a zoom area.

Previous view:

- Click on or select Previous in View menu.

Original View:

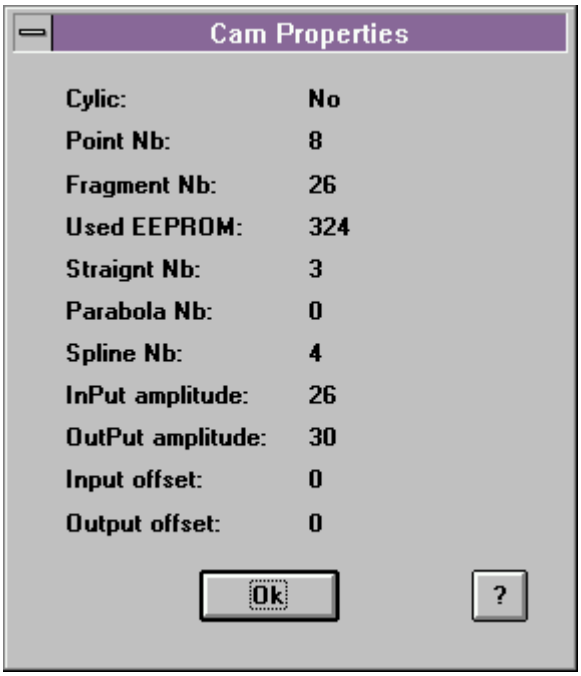
- Click on or select Original in View menu.

5.3 INFORMATION

There are some dialogue boxes which can give you information about the actual cam. These dialogue boxes are:

5.3.1 CAM PROPERTIES

You can open it selecting Properties option in Cam menu.



The input/output amplitude and offset take only the user's points into account. It means that the interpolation can produce under- and overshoots which are not shown here but which you can control with the cam check utility.

5.3.2 CAM INFORMATION

You can open it selecting Info option in Cam menu. It gives information on the last save: